The Supersaturation and Nuclear Condensation of Certain Organic Vapours.

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(Abstract.)

The condensation of drops, which takes place when dust-free air saturated with an organic vapour is cooled by an adiabatic expansion, is the subject of this investigation. The experiments were made with the air and vapour (1) in their natural state, (2) ionised by Röntgen rays.

The apparatus used was in principle the same as that of Mr. C. T. R. Wilson in his experiments with water vapour. The essential part of it is an expansion chamber in communication with a glass cylinder, in which a gas-tight piston slides freely. When a trigger is pulled the piston descends, and a very rapid (adiabatic) expansion of the air and vapour is obtained. The expansion was determined from the initial and final readings of a pressure gauge. The illumination of the expansion chamber was such as enabled any drops formed by the expansion to be readily seen. The liquids used in the experiments were carefully purified.

When the air and vapour are expanded adiabatically their temperature falls, and the pressure of the vapour at this lower temperature is greater than that which it has over a plane surface of the liquid at the same temperature. This supersaturation, however, may not cause the condensation of drops in dust-free air. Expansions of increasing magnitude were made until condensation took place, and then the least expansion required to produce condensation for the conditions of the experiment was determined.

In another series of experiments the expansion chamber was so made that in one part of it the positive ions produced by Röntgen rays were in excess, and in the other adjacent part the negative were in excess; the expansion was identical in both and the result of it could be observed in the two parts simultaneously. In this way the relative efficiencies of the ions as condensation nuclei could be examined.

The results of the investigation may be summarised as follows:—

(1) The least expansion, which causes condensation in air initially saturated with an organic vapour and ionised by Röntgen rays, has been

determined for five esters, six acids (formic to iso-valeric), and iso-amyl alcohol.

(2) In the case of acetic acid the expansion required was greater for feeble Röntgen rays than for more intense ones.

(3) The supersaturation, S, existing at the end of each of the expansions mentioned in (1) has been calculated, and also for four alcohols and chloroform from Przibram's experiments.

(4) The acids are found to have the largest values of S and the alcohols the least. The isomers examined have the same value for S with one exception. In the case of the alcohols, ethyl to iso-amyl, a fairly regular decrease in S accompanies the addition of a CH_2 group.

(5) The existing theory of condensation on ionic nuclei has been given, values of S have been calculated from it, and compared with S deduced from the observed expansions. The agreement in the case of acetic, propionic, *n*-butyric, and iso-butyric acids, and methyl alcohol is very close.

(6) The expansion and supersaturation necessary for condensation on the natural nuclei have been determined for the same (dust-free) vapours. In the case of formic, acetic, and butyric acids a distinctly greater expansion is required to catch the natural nuclei than that required for the ionic nuclei produced by Röntgen rays.

(7) As the expansion was increased the number of drops usually increased continuously with it so that the fog point was ill defined, except in the case of tertiary amyl alcohol.

(8) Ethyl acetate, methyl butyrate, propyl acetate, acetic acid, and iso-amyl alcohol were found to condense for a smaller expansion on the positive nucleus than on the negative. Water is the only known substance for which the negative ionic nucleus is more efficient than the positive.

(9) On bubbling air through methyl, ethyl, and iso-amyl alcohols, ethyl acetate, propyl acetate, methyl butyrate, chloroform, and ethyl iodide they became negatively electrified. This was the sign of the electrification to be expected from Professor Thomson's double layer theory of the relative efficiency of ionic nuclei. Acetic acid was not in agreement with the theory for it became positively charged on bubbling.